

# Interactive Lake Ecology's Guide to Field Studies

August 4, 2003

New Hampshire Department of Environmental Services  
Water Division  
Watershed Management Bureau  
Biology Section  
6 Hazen Drive  
Concord, NH 03301  
(603) 271-2963  
[www.des.state.nh.us](http://www.des.state.nh.us)

Alicia Carlson  
Principle Author

Michael P. Nolin  
Commissioner



*Printed on Recycled Paper*



# Interactive Lake Ecology's Guide to Field Studies

<b>Acknowledgements .....</b>	<b>5</b>
<b>Introduction .....</b>	<b>7</b>
Why use the Guide? .....	7
Contents .....	7
Preparing and Organizing .....	8
Safety .....	9
Participants .....	9
Equipment .....	10
<b>Activities .....</b>	<b>11</b>
<b>Part I: Conducting Surveys .....</b>	<b>11</b>
Activity 1: Aquatic Weed Survey .....	12
Activity 2: Shoreline Development Survey .....	14
Activity 3: Bathymetric Mapping .....	15
Activity 4: Stream Survey .....	17
Activity 5: Benthic Macroinvertebrate Survey .....	19
<b>Part II: Collecting Water Samples .....</b>	<b>21</b>
Activity 6: Transparency .....	22
Activity 7: Chlorophyll .....	23
Activity 8: General Water Quality .....	25
Activity 9: Plankton .....	26
<b>Part III: Making Equipment for Lake Studies .....</b>	<b>29</b>
Activity 10: Secchi Disk .....	30
Activity 11: Integrated Sampler .....	31
Activity 12: Plankton Net .....	32
Activity 13: Viewscope .....	33
<b>Appendix .....</b>	<b>35</b>
Shoreline Development Field Data Sheet .....	36
Stream Survey Field Data Sheet .....	37
Benthic Macroinvertebrate Survey Field Data Sheet .....	38
Equipment and Test Kit Suppliers .....	39

All Interactive Lake Ecology program workbooks and guides can be ordered from the New Hampshire Department of Environmental Services:

NH Department of Environmental Services  
Watershed Management Bureau  
6 Hazen Drive, PO Box 95  
Concord, NH 03302-0095  
Phone: (603) 271-2963  
Fax: (603) 271-7894  
<http://www.des.state.nh.us/wmb/ILE/>



## **ACKNOWLEDGEMENTS**

The author wishes to acknowledge the individuals who helped to review and provide content for this Guide to Field Studies: Andrea LaMoreaux, Amy Smagula, Sara Sumner, Jody Connor, and Jennifer Drociak.

The author would also like to thank Mark Denoncour, a Concord, NH, teacher , for initiating this program.

Also, a special thanks to the Department of Environmental Services' Nonpoint Source Program's Local Initiative Grant for financial support of the Interactive Lake Ecology curriculum.



## INTRODUCTION

### **Why use the Guide?**

The Interactive Lake Ecology (ILE) Program was developed to encourage students to learn more about lakes and ponds. By taking students out onto a lake, teaching them how to use sampling equipment, and discussing the land uses in the watershed, students typically develop a greater understanding of why it is so important to protect our freshwater resources. This guide gives examples of on-shore and in-lake activities in which students can easily participate.

The ILE “Guide to Field Studies” was created to aid teachers who would like to take their students on field trips, but need some guidance. This guide gives detailed examples of activities for enjoyable and productive outings. It is important to note that the activities in this guide can be altered to meet your students’ needs.

While the ILE Student Workbook presents detailed lake ecology concepts, this guide is specific to field sampling procedures. Included in this text are in-depth descriptions of how to conduct different surveys around a lake, how to use equipment, and proper procedures for collecting water samples.

### **Contents**

This guide begins with examples of preparing for and organizing a field trip. It then discusses surveys that can be conducted in and around a lake, equipment, and sampling procedures. Also included in the guide are instructions for constructing equipment and a resource list for ordering equipment and kits to analyze samples, if you choose to do so.

The text of the Guide to Field Studies references concepts discussed within the ILE Student Workbook.

## **Preparing and Organizing**

There are several aspects of limnology that may be included in a field trip. Below are just a few ideas. Please feel free to alter this program to meet the students' needs. Some teachers may want to collect water samples for analysis by a lab or by the students back in the classroom. Other teachers may not collect any samples at all. Many teachers find that giving their students the opportunity to use the sampling equipment is sufficient. Here is a list of activities you and your students can try on a field trip:

- ◆ Using a Kemmerer bottle or sounding device to determine the maximum depth of the lake.
- ◆ Using a Kemmerer bottle to collect a water sample for analysis of pH and other simple chemical analyses.
- ◆ Using a Secchi disk to determine the clarity of the water.
- ◆ Recording the students' findings on data sheets.

A more in-depth field trip could include:

- ◆ Using a plankton net to collect samples of phytoplankton and zooplankton for observation and identification in the classroom.
- ◆ Completing an aquatic weed survey.
- ◆ Conducting a shoreline development survey.
- ◆ Constructing a bathymetric map.
- ◆ Conducting a benthic macroinvertebrate survey.

These activities will all be discussed later in the guide. The results from the field trip may be used as an additional case study for Experiment 19 in the ILE Student Workbook (associated with Chapter 9: Classifying Lakes).

Once you know what you want to accomplish, make a list of the necessary items (i.e., equipment, whose help to enlist) and determine the time necessary to carry out the activity. Determine where the field trip should occur and make any needed arrangements with landowners, officials, and for transportation.

## **Safety**

The most important issue that comes to mind when going out on a lake is student safety. Here is a list of some necessary safety equipment to have on a boating field trip:

- ◆ Map of the lake
- ◆ Horn or whistle
- ◆ Fire extinguisher
- ◆ Magnetic compass
- ◆ Paddles
- ◆ Anchor and line
- ◆ First aid kit
- ◆ Sunscreen
- ◆ **Life vests for each student and chaperone!**

Be sure to follow all boating rules. Please do not go out if the weather looks foreboding. If winds pick up and storm clouds are moving in, head back to shore immediately. Strong winds and white cap conditions should also be avoided. Collection of data is often difficult in these situations. For more safety information, contact your local aquatic safety or environmental agency.

## **Participants**

All groups must cooperate to make the field trip a success. Here are some groups that may be involved and their suggested duties :

### State or Local Environmental Agency

- ◆ Supply educational materials, including lake maps
- ◆ Visit classroom for lake ecology presentation prior to field trip
- ◆ Provide the teacher with a list of lake associations and volunteer monitors who are interested in helping with educational field trips
- ◆ Give technical support

### Volunteer Monitors or Lake Residents (if available)

- ◆ Arrange for boats to transport students
- ◆ Ensure proper safety equipment is on board prior to field trip
- ◆ Have extra equipment available
- ◆ Visit the class to discuss the history of the lake prior to the field trip
- ◆ Give helpful hints for sampling
- ◆ Help set up a timeline for the trip

### Teacher

- ◆ Coordinate all arrangements for the trip with the environmental agency, volunteer monitors, students and parents
- ◆ Break the class into groups beforehand and assign a task to each group (discussed on page 11)
- ◆ Review safety rules with the students

- ◆ Introduce the appropriate chapters in the ILE Student Workbook before the field trip
- ◆ Ensure that **ALL** students have life vests

#### Students

- ◆ Learn safety rules
- ◆ Study equipment and instruments to be used
- ◆ Review the appropriate chapters in the workbook
- ◆ Act responsibly!
- ◆ Take notes of the day's activities and keep in logbook or field data sheets

#### Parents

- ◆ Help chaperone the field trip
- ◆ Assist the teacher with last minute details

Proper planning is essential for an educational and effective field trip. By creating a schedule beforehand, many problems will be avoided on the day of the trip. If this will be a full day event, consider moving the students around between several stations. This will depend on the number of students and the available chaperones. Regardless, having a timed schedule will help the day move more smoothly.

The teacher might also consider enlisting students to keep track of the equipment. Each student can be responsible for one piece of equipment, making sure that it gets to the lake and back safely.

### **Equipment**

The list of necessary equipment for an in-depth field trip may include:

- ◆ Sounding device
- ◆ Kemmerer bottle (or Van Dorn sampler\*) with clip and weights
- ◆ Integrated sampler
- ◆ Secchi disk
- ◆ Plankton net
- ◆ Calibrated line
- ◆ Sample collection bottles
- ◆ Lake outline map
- ◆ Anchor and line

Some surveys and other activities require equipment not listed above. Please refer to each activity for a complete list.

*\*Van Dorn samplers are similar to Kemmerer bottles. They have the same function but are designed differently. If you need to purchase equipment, the Van Dorn sampler may be cheaper. If you are borrowing equipment from a laboratory, they may supply you with either a Van Dorn sampler or a Kemmerer bottle. The Kemmerer bottle was used throughout the text of the Guide to Field Studies.*

## ACTIVITIES

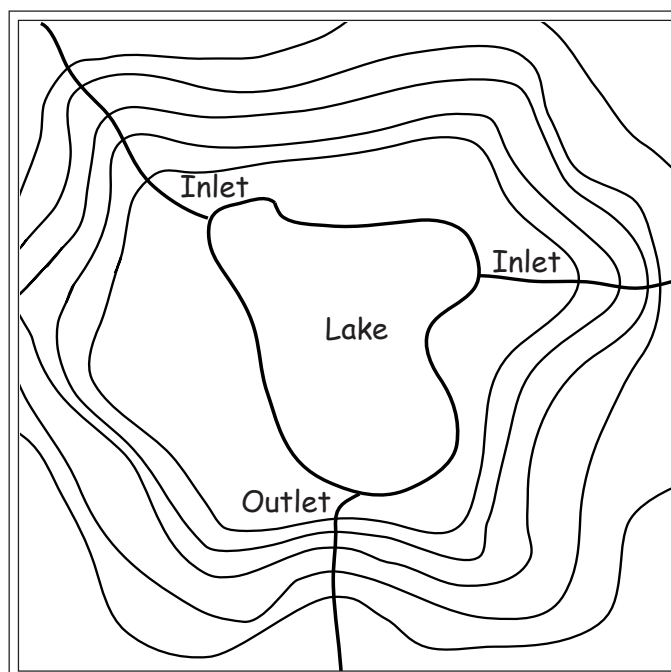
### Part I: Conducting Surveys

There are many different aspects of lake ecology that the students can learn on a field trip. This guide gives several examples: aquatic weed survey, shoreline development survey, bathymetric mapping, and benthic macroinvertebrate survey. You may want to have each group complete all of these activities, or assign one activity to each group to complete in the allotted time.

No matter which is chosen, make sure each group knows how much time they have to finish their assignment and when to return to the meeting place. Having two-way radios on hand is a good way to keep in contact with all groups.

The following surveys require an outline map of the lake shoreline. Contact the state's environmental agency to obtain an outline of the lake the class will visit. If the agency does not have an outline, you can make your own. Follow these easy steps:

1. Find the lake in your state Gazetteer, or on a USGS topographic map (this is usually a larger scale than the Gazetteer).
2. With a transparency marker and transparency sheet, trace the shoreline of the lake and indicate which direction is north.
3. Place the transparency on an overhead projector and project the outline onto a piece of paper (choose the paper size you feel will yield the most accurate outline. For example, if the lake is large you may want a large piece of paper so the information won't be confined to a small space.)
4. Include all tributaries (inlets) and outlets to the lake. To determine whether the stream is an inlet or an outlet, look carefully at the topographic map for the direction in which the contour lines point. If the valley points away from the lake, the stream is an inlet. If the valley points towards the lake, the stream is an outlet. Refer to the diagram below. \*Remember: Accuracy is important!
5. Have a student trace the projected image onto the paper. Make copies for each survey.



## **Activity 1: Aquatic Weed Survey**

Limnologists use aquatic weed surveys to help classify and determine the overall water quality of lakes and ponds. This concept is studied in the ILE chapter “Classifying Lakes”.

### **Necessary Equipment**

- ◆ Lake shoreline map
- ◆ Clipboard and pencil
- ◆ An aquatic plant field guide
- ◆ Bucket (for collecting samples)
- ◆ Rake or net (to collect unknown plants)
- ◆ Viewscope, if available (This is a tube with one open end and the other end with a plastic window to see below the water’s surface; make your own - Appendix, page 33.)

### **Directions**

This survey can be completed by boat or by walking along the shore. The method you choose will depend on the time allotted for this activity and the available resources. If you want the students to become experienced at identifying plants, walking along a portion of the shoreline will be sufficient. If, however, you would like the students to create a map, using a boat is a better option. The students may not see submerged plants (those that grow beneath the surface of the water) by walking along the shore, since many of these grow in slightly deep water.

### **Option 1**

If a boat will be used for this survey, follow these steps:

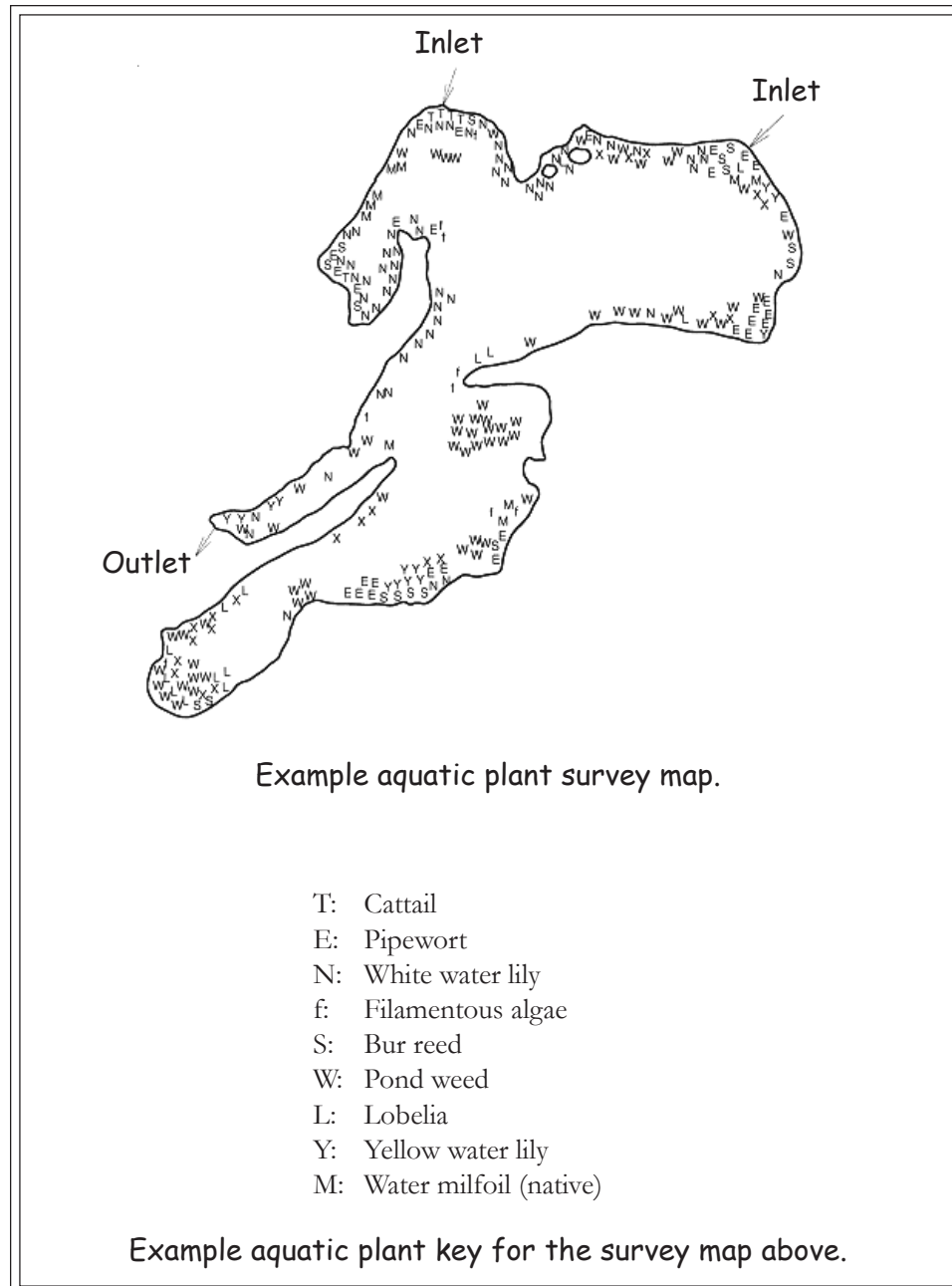
1. Start at an area that is easily identified on the lake outline. This may be a point that sticks out from the land, a tributary, or dam. Locate the area on your map.
2. Look for any plants in the water. Make sure to look under the surface of the water using the viewscope. If the plant is not one that you know, use the rake to bring it into the boat. Try to identify the plant using the field guide. If it is not easy to determine what the plant is, put it in the bucket with some water and try again in the classroom.
3. Mark the location on the map where the plant was found. Use specific numbers or letters to associate with each plant type. (For example, for a white water lily use “W”, and for a yellow water lily use “Y”). This prevents the map from becoming cluttered. Make a key of all of the numbers/letters that are being used along with the associated common names on the map for later reference (see the example on page 13).
4. Begin moving around the lake as close to shore as you can get the boat. Continue marking the plants on the map until you return to the starting point. If there are any islands, be sure to survey around those as well.

If you return to the same lake year after year, the students can compare the previous years’ aquatic weed survey results. This will allow them to understand that plants can become more or less abundant in some areas of the lake and different plant species may take over.

### **Option 2**

If a boat is not available, a pair of hip waders might be helpful in order to find the submerged plants by walking the shoreline. Be sure to ask for permission from landowners to either walk along their property or to

use their dock. Follow steps 2 and 3 above. For a more simplified survey, simply make a list of the plants that were found and identified.



## **Activity 2: Shoreline Development Survey**

Evaluating the shoreline and surrounding watershed of a lake can help a limnologist understand where pollutants and nutrients could potentially enter the water. This exercise will help students better understand the impacts humans can have on water quality by the actions they take near a waterbody.

This survey can also be conducted by boat or land. In most cases, a boat will be most useful. If the lake is small and has a path or roads surrounding a majority of it, then you might want to have the students walk around the lake.

### **Necessary Equipment**

- ◆ Lake outline map
- ◆ Watershed map
- ◆ Clipboard and pencil
- ◆ Shoreline Development Field Data Sheet (Appendix, page 36)
- ◆ Camera (optional)

### **Directions**

Before conducting this survey the class should brainstorm (with help from the case studies in Chapter 9: Classifying Lakes) things they should be looking for when at the lake. The list can include but is not limited to the following:

- ◆ Condominiums/hotels
- ◆ Single family dwellings
- ◆ Docks/marinas
- ◆ Sandy beaches (include the number and approximate size)
- ◆ Natural vs. introduced vegetation
- ◆ Impervious surfaces (parking lots, paved driveways and roads, roofs, etc.)
- ◆ Forestry activities
- ◆ Construction activities (look for best management practices like silt fencing or hay bales)
- ◆ Proximity of roads to the lake (note erosion or runoff)
- ◆ Commercial development
- ◆ Trash

Have the students look for the activities from their list. They should mark on the lake outline map where each land use or activity is occurring and draw in any additional items of interest. This may include a pipe that they find adding water to the lake, any place they notice a strong odor, or signs of erosion.

### **Activity 3: Bathymetric Mapping**

Usually a limnologist will collect samples at the deepest point in the lake. To find where the deep spot is located, a bathymetric map (lake depth contour map; discussed in Chapter 8 of the Student Workbook) must be created. Using a sounding device to find the depths at points along several transects of the lake is the most accurate method. The size of the lake will determine how many transects should be made.

#### **Necessary Equipment**

- ◆ Lake outline map
- ◆ Clipboard and pencil
- ◆ Sounding device (a device that records depth, like a fathometer or fish finder - **Option 1**)
- ◆ Boat (**required**)
- ◆ Kemmerer bottle (**Option 2**)
- ◆ Calibrated chain (**Option 2**)

#### **Directions**

This activity can take up to an hour to complete, depending on the size of the lake. It is probably the most time-intensive survey to conduct.

##### **Option 1**

Here is the **best method** for completing the bathymetric map:

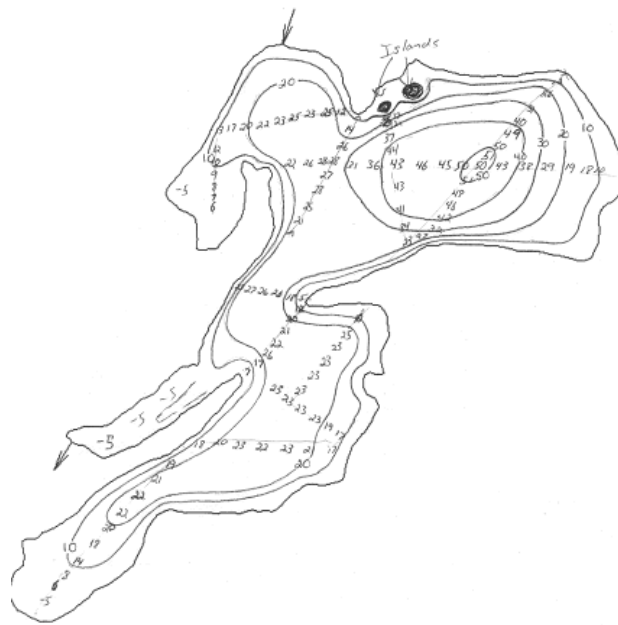
1. Have the students select a good place to start. Try to start from an easily identifiable area on the lake outline map (i.e., an inlet or a point of land).
2. Decide where to make the first line across the lake. Find another easily identifiable area on the opposite shoreline. You will travel from the first point to the second marking the depths along the way, creating a “transect”.
3. Set up the sounding device. Go slowly enough so the sounding device is reading a depth. (If you go too fast, it won’t work!)
4. Mark the depths on the outline map along the transect.
5. Once at the end of the first transect, decide where the next line should begin. Pick a point of land opposite of where the boat is positioned, but in a different direction from which you just traveled.
6. Continue until a majority of the lake has been sounded.
7. Back in the classroom, have the students complete the map by drawing lines between the boundaries of depths. Depending on how deep the lake is, choose an appropriate depth increment (generally 5- or 10-foot increments are most suitable). Refer to page 16 for examples of a draft and finished map.
8. Compare your results with a bathymetric map of the same lake done by the state environmental agency.

##### **Option 2**

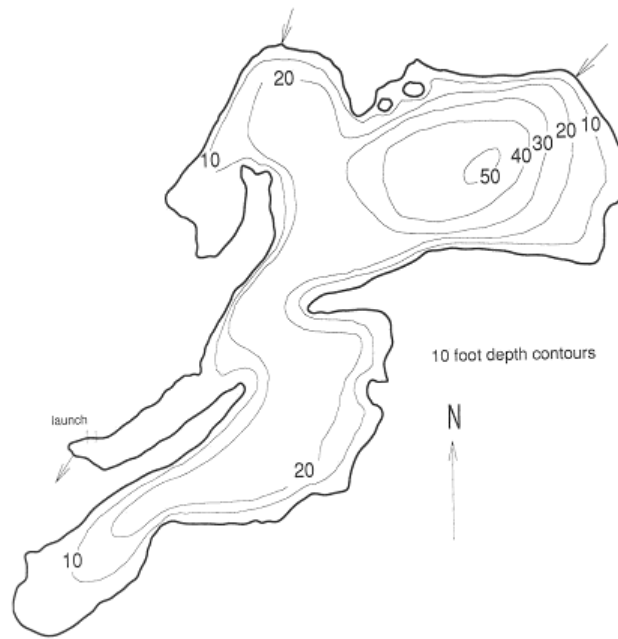
If a fathometer, or other sounding device, is not available for your use, a Kemmerer bottle may be used. This method will not be as accurate and will take much longer. Therefore, this is recommended only on small lakes or to give the students a general understanding of the concept. Refer to page 21, steps 1 through 6, for a detailed description to set up the Kemmerer bottle.

1. Fill the Kemmerer bottle with water and close it. This will add extra weight, so it will be easier to feel the bottle when it touches the lake bottom.

2. Slowly, lower the bottle into the water until the chain goes slack. Once the chain is slack, the bottle is at the bottom. Try to not drop the bottle repeatedly onto the lake bottom, as this can disrupt the bottom sediments, disturb any bottom-dwelling organisms, and add unwanted nutrients to the lake.
3. Take the depth reading from the chain at the surface of the water and mark it on the outline map.
4. Continue taking depth readings along a transect. Make as many transects as you feel are necessary for an accurate map.



Example of a draft bathymetric map.



Example of a finished bathymetric map.

## **Activity 4: Stream Survey**

To conduct a stream survey, the class will walk along the banks of a stream. Typically it is best to start at the lake/pond edge and then follow the stream towards its headwaters (where it originates). It is not necessary to walk the entire stream (particularly if it is long) as the students will get a general understanding in a short walk.

### **Necessary Equipment**

- ◆ Clipboard and pencils
- ◆ Stream Survey Field Data Sheet (Appendix, page 37)
- ◆ Watershed Map (a street map may work as well)
- ◆ Camera with color film or color digital camera
- ◆ 50-foot tape measure (to measure the area of the potential pollution-causing sites and the distance from the stream)
- ◆ Flashlight with fresh batteries (useful for checking pipes and as a safety precaution)
- ◆ Sample bottles and a backpack for carrying bottles (if you plan to collect samples)

### **Directions**

Be sure to receive permission from all landowners prior to the visit. Explain that this is an educational event for the students.

Look for any of the following problems, or have the students brainstorm prior to the trip (similar to the Shoreline Development Survey):

- ◆ Bare/exposed soil
- ◆ Signs of erosion (gullies and rills)
- ◆ Cloudy (turbid) water
- ◆ Sediment deposits in the water
- ◆ The pathway of stormwater runoff in the area (document if the runoff is going directly into a ditch, stream, or lake)
- ◆ Absence of a vegetated buffer
- ◆ Properly or improperly installed erosion and sedimentation barriers around disturbed sites (such as hay bales and silt fencing)

The class may also wish to note the following:

- ◆ Construction areas
- ◆ Agricultural areas
- ◆ Residential or commercial development
- ◆ Signs of or observed wildlife

Follow these instructions:

1. Observe the land uses in the immediate vicinity of the stream.
2. Fill out the Stream Survey Field Data Sheet.
3. Mark and label the potential sources of pollution along the stream on a topographic map.

4. Measure the distance from the potential water quality problem area to the stream, and also note the slope of the land.
5. If the class is prepared to analyze samples, collect samples upstream and downstream of potential pollution sources.
6. Label all bottles and mark on the map where each sample was collected.

## **Activity 5: Benthic Macroinvertebrate Survey**

Benthic macroinvertebrates (organisms without a backbone that live in the bottom of a lake, pond, or stream) are an important indicator of water quality. Many organisms can survive only in clean waters, while others can survive in polluted waters. Limnologists look for macroinvertebrates in lakes, ponds, streams and rivers to help them determine water quality.

Many students enjoy this activity because they can look at living creatures. They can understand why it is important to keep lakes and streams clean if they see the organisms that live in the water.

### **Necessary Equipment**

- ◆ A tray (or a cookie sheet with sides)
- ◆ Waders or hip boots
- ◆ Kick net (if available)
- ◆ Bucket
- ◆ Insect identification book or pictures
- ◆ Macroinvertebrate Field Data Sheet (Appendix, page 38)

### **Directions**

Create the data sheets in the classroom prior to the field trip (refer to the example on page 38 of this guide). Include a section for the waterbody name, town, student names, and a table to list all identified species. In the table, provide a column for common name, pollution tolerance (this can be found in most identification books), and general description. Leave room on the paper for sketches of the organisms.

This activity is best demonstrated at a stream. Try to choose a stream that contains still pools as well as moving currents. Also, look for rocky and sandy sediments. The students may find different species of macroinvertebrates in each of these areas.

1. Have students stand in the stream in their waders. **It is best to avoid heavy currents.**
2. One student should pick up rocks, twigs, leaves and other debris that are resting in the stream bank.
3. A second student on shore, with the bucket partially filled with stream water, will gently rub the debris.
4. Examine the contents of the bucket to locate any insects or other organisms that have dislodged from the debris. Place organisms in the tray.
5. A third student will stand in the water holding the kick net (the net opening should be facing upstream). Standing slightly upstream, gently disturb the sediment directly in front of the net with your feet. Any organisms in the water will float into the net. After about 10 to 30 seconds of this, gently pull the kick net out of the water and search for macroinvertebrates. Look carefully under twigs and other debris. Place them in the tray.
6. On the shore of the stream, have the students use the identification book or pictures to identify the species. The students should fill out the data sheets as completely as possible.
7. When finished, gently return the insects to the area of the stream where they were found. Do not return to the classroom with the insects.



## Part II: Collecting Water Samples

This is one of the best ways for students to understand the life of a limnologist. Limnologists collect and analyze water samples on a routine basis. There are several tests for which samples are collected; these are described in this section.

### Necessary Equipment

- ◆ Kemmerer bottle with weights
- ◆ Secchi disk
- ◆ Plankton net
- ◆ Calibrated line (chain or rope) with depths
- ◆ Boat with anchor (**Important! Use a boat anchor or heavy object, such as a cinder block, tied to a rope.**)

### Directions - Finding the Sample Depth

First, we need to discuss finding the bottom depth of the sampling location (also known as “sounding” the bottom). The teacher might decide that sampling in the deepest part of the lake will not be appropriate for the students. For instance, these activities can be done at a dock so the students can get experience using the equipment and understand the methods. Wherever samples will be collected, the bottom depth can be determined by using a Kemmerer bottle.

1. Thread the calibrated line through the hole of the the smaller weight. Either a chain with markers or a rope with predetermined depth lines can be used. If a rope is used, be sure to re-measure the depth markers each year as rope can stretch when wet.
2. Thread the calibrated line through the top of the central rod of the Kemmerer bottle until it comes out the bottom. If using a chain, keep it in place with a clip threaded between 2 or 3 links. If using a rope, tie a knot at the end, **tightly!**
3. Add the larger weight to the chain/rope above the sender. (See the diagram on page 26.)
4. Open the Kemmerer bottle by pulling on both ends at the same time until a “click” is heard. When holding the bottle upright by the chain the bottle should remain open.
5. Rest the smaller weight on top of the Kemmerer bottle and lower into the water.
6. With the bottle just below the surface, release a second weight down the chain so the bottle closes. This collects water in the bottle, which acts as a weight when lowering it to the bottom of the lake.
7. Slowly lower the bottle into the water column. Once the bottle hits the bottom, the chain should slacken. Pull the chain up slightly and let it down again. The operator may be able to feel the bottle as it hits the bottom. (This may not occur in deep lakes or lakes with a mucky bottom. Sometimes it is difficult to know when the bottle has hit, in which case, it would be better to use a fathometer.)
8. Grab the chain from the surface of the water. Try to determine the depth to the nearest tenth of a meter. (If using feet, try for the nearest 6 inches.)
9. Pull the Kemmerer bottle up and empty the water from the bottle.
10. Once the depth is known, lower the anchor into the water to keep the boat from drifting. If you are out with volunteer monitors, they may already know where the deep spot is by locating 2 or 3 predetermined points on land. This is known as “triangulation” and is a very helpful technique to locate the same spot on each sampling day.

## **Activity 6: Transparency**

Transparency (clarity) is determined by using the Secchi disk. This activity seems to be the most understandable for students. Also, it's fun for them to compare their results, since different people will see the disk at different depths, depending on their vision.

### **Necessary Equipment**

- ◆ Secchi disk (make your own - Appendix, page 30)
- ◆ Calibrated chain or rope
- ◆ Viewscope (optional: this is a tube with one open end and the other with a plastic window - Appendix, page 33)

### **Directions**

Before setting up the Secchi disk, explain to the students that the closer they are to the water the more accurate the results will be. The reflection of the sun and ripples or waves on the lake surface may affect the depth to which the disk can be seen. Therefore, students should get as close to the water as possible, without falling in! Other points to explain are that the disk should be viewed on the sunny side of the boat and sunglasses should be removed. While it was just explained that the sun might hinder viewing, it does help to have the sunlight entering the water column. Sunglasses can make the disk more difficult to view, unless they have polarized lenses. Try both sides of the boat (sunny and shady) to see which works best for you.

1. Set up the Secchi disk by securely fastening the rope or chain to the eyehook.
2. Place the disk in the water and lower it slowly. Pay close attention when the disk begins to disappear.
3. Once the disk has disappeared entirely from view, slowly pull up on the rope/chain until the white quadrants are visible to the viewer. It may be a very faint sight, or the white sections may appear colored (e.g., orange), depending on suspended solids in the water column.
4. Take hold of the rope/chain at the water's surface and then determine the depth to the nearest 1/10 of a meter (or 6 inches).
5. If a viewscope is available, have the students view the Secchi disk in the water once without the viewscope and a second time with it. Since the viewscope can be placed beneath the surface of the water, it generally increases the depth to which the Secchi disk can be viewed. Waves and sun glare will not affect the depth reading with a viewscope. Have them try both techniques to see if it makes a difference.

As stated before, students seem to enjoy this activity most. Therefore, you may want to have each student try. Besides, more individual results will yield a more accurate average transparency!



A Secchi Disk.

## **Activity 7: Chlorophyll**

**NOTE:** This activity is complicated. Unless you are collecting samples for analysis by a professional laboratory, you may want to skip this section. Find out from your state's environmental agency if they will accept this sample from your students and the required sample collection method (it may vary from the description below).

Chlorophyll was discussed in Chapter 9: Classifying Lakes (ILE Student Workbook). Chlorophyll is a pigment found in all plants and phytoplankton. The test for chlorophyll measures the abundance of phytoplankton in the water. By collecting water from the depth where light penetrates the lake water (the photic zone), phytoplankton will inadvertently be captured. The sample of water can be filtered in a lab to “squeeze” the chlorophyll from the phytoplankton cells.

### **Necessary Equipment**

- ◆ Kemmerer bottle or Integrated sampler (make your own - Appendix, page 31)
- ◆ Chain or rope with depth markings
- ◆ Bucket
- ◆ Dark collection bottle

The dark collection bottle is important. Phytoplankton use sunlight for photosynthesis to produce energy and food for themselves. Since chlorophyll is a part of photosynthesis, any light that reaches the phytoplankton after they have been collected may yield inaccurate results.

### **Directions**

After determining the depth of the lake, the students can decide where to collect a chlorophyll sample. In shallower lakes, limnologists generally begin from two-thirds of the total depth of the water; in deeper lakes, start from the average transparency depth.

There are two methods: the method using the Kemmerer bottle and the integrated sampler method; each is described below.

#### **Option 1: Kemmerer bottle**

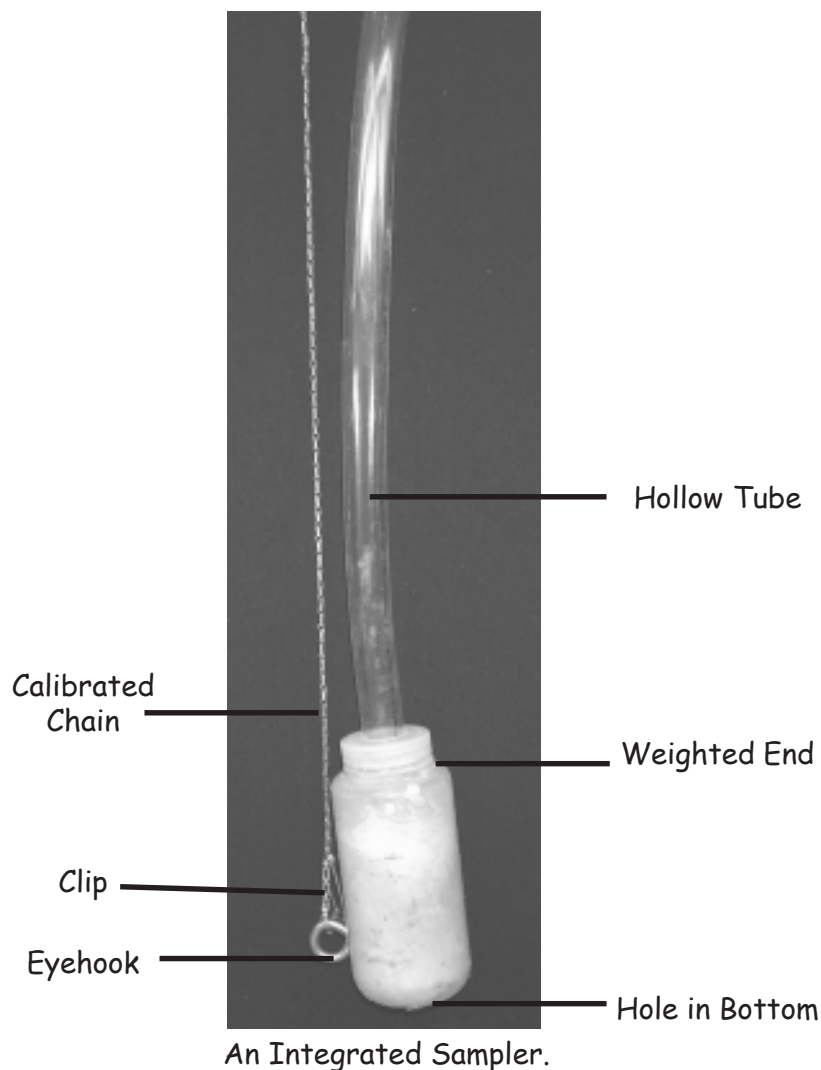
1. Lower the Kemmerer bottle to the predetermined depth to collect a water sample.
2. Empty the contents of the Kemmerer bottle into the bucket. Make sure to empty an equal amount of sample from each depth - if you empty half the Kemmerer bottle for the first depth, do the same for the remaining depths.
3. Collect water samples throughout the remaining water column at every meter/foot up to the surface. (e.g., If you start at 6 meters, collect from 6, 5, 4, 3, 2, and 1 meters.)
4. Mix all of the water in the bucket. Rinse the dark collection bottle by dunking it into the bucket, swishing a little water inside the bottle, and emptying the bottle over the side of the boat.
5. Fill the collection bottle with water from the bucket. Label the bottle with lake name, town, date, time, and the depth.
6. Transport to a laboratory or the classroom for analysis.

#### **Option 2: Integrated Sampler**

If the depth from which your students collect the chlorophyll-a sample is **4 meters or greater**, it is suggested that you use the integrated sampler method. The amount of time involved using the integrated sampler method to collect the chlorophyll-a sample from 4 meters or greater will be *much less than* would be

involved using the Kemmerer method. (Note: The integrated sampler method is not appropriate for lakes/ponds where the chlorophyll-a sample is taken from less than 4 meters because the amount of sample water collected in the tube may not be adequate to fill up the chlorophyll bottle.)

1. Connect the weighted end of the integrated sampler to a calibrated chain.
2. Lower the tube and the chain at the same rate from the surface to the middle of the metalimnion in stratified lakes or 2/3 of the total depth in unstratified lakes. Be careful to not twist the chain and tube.
3. Crimp the tube at the water surface and then haul up the weighted end by the chain to the surface. Keep the tube at the water's surface. (Think of having a straw in a glass of water. When you cover the end of the straw with your finger, all the water remains in the straw until you remove your finger.)
4. Place the weighted end of the tube in a bucket and then uncrimp the tube; this causes the sample water to flow into the bucket. As the water releases into the bucket, help it along by moving the water through the tube.
5. Fill the chlorophyll-a bottle with the integrated sample water. Label the bottle with lake name, town, date, time, and depth.
6. Transport to a laboratory or the classroom for further analysis.



## Activity 8: General Water Quality

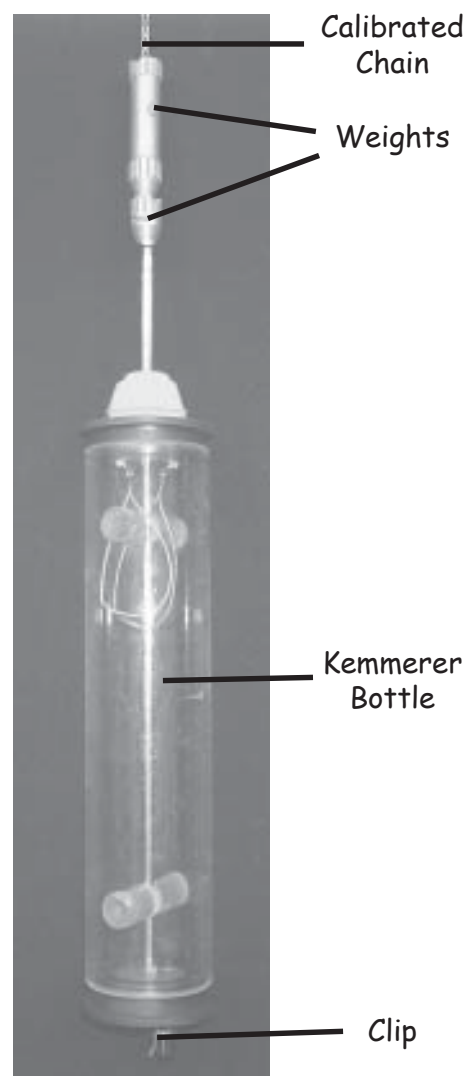
Find out from your state's environmental agency what tests they usually run on lake water. They may be willing to offer assistance in the analysis. There are also classroom kits available for student to analyze samples. Refer to the resource list in the appendix for contact information. Generally, appropriate analyses include pH, conductivity, turbidity, and nutrients.

### Necessary Equipment

- ◆ Kemmerer bottle and weights
- ◆ Calibrated chain
- ◆ Clip (to secure bottle)
- ◆ Sample collection bottles

### Directions

1. Set up the Kemmerer bottle with the calibrated chain and weight, as shown at right.
2. Determine at what depths the students will collect samples. Generally, a limnologist determines the layers (refer to Chapter 2 "Water Properties") of a lake by measuring the temperature throughout the water column.
3. Prepare sample bottles for each depth.
4. Open the Kemmerer bottle by pulling on both ends at the same time until a "click" is heard. When holding the bottle upright by the chain the bottle should remain open.
5. Rest a weight on top of the Kemmerer bottle and lower into the water.
6. Lower the bottle with the calibrated chain until it reaches the predetermined depth.
7. Drop the larger weight down the chain to close the bottle. This collects water in the bottle.
8. Raise the Kemmerer bottle to the surface by pulling up on the calibrated chain.
9. Empty the contents of the Kemmerer bottle into a sample bottle. Most Kemmerer bottles have a spring at the bottom (near the clip). Push up on the spring and water will release from the Kemmerer bottle.
8. Transport samples to a laboratory or the classroom for analysis.



A Kemmerer Bottle.

## **Activity 9: Plankton**

Identifying plankton samples is an interesting part of a lake ecology study program. Observing the microscopic organisms found within the water helps students understand the complexity of a lake food web (ILE Student Workbook, Chapter 4: Food Chains).

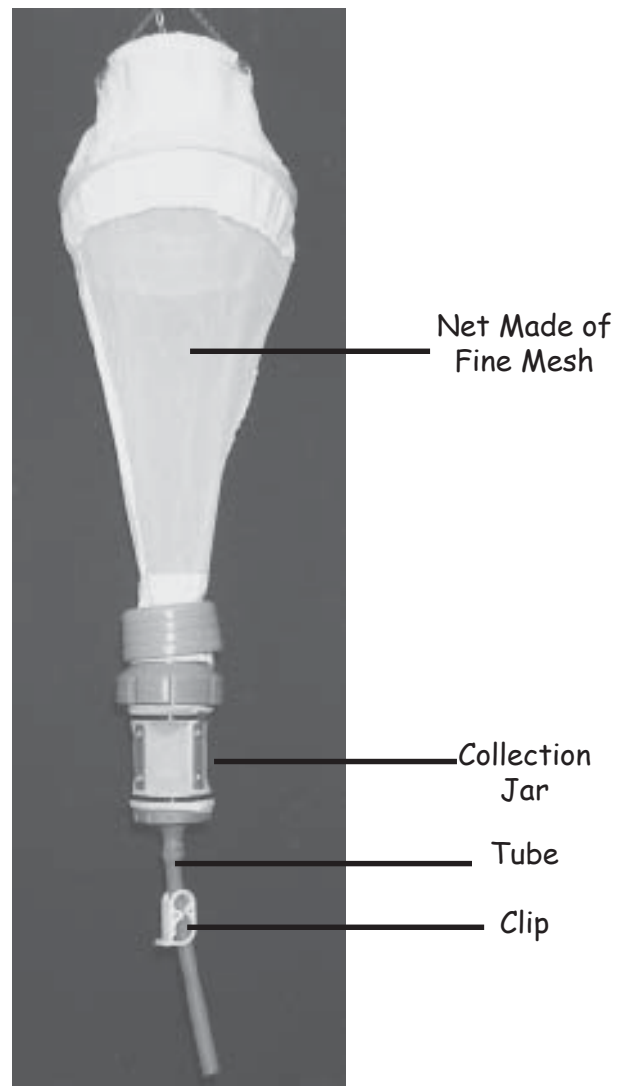
### **Necessary Equipment**

- ◆ Plankton net
- ◆ Calibrated chain or rope
- ◆ Sample collection bottle (preferably transparent; however, use caution with glass containers)
- ◆ Microscope (a basic model should be sufficient)
- ◆ Microscope slides
- ◆ Pipette (for placing sample on slide)
- ◆ Plankton identification book

### **Directions**

There are a few methods for collecting plankton samples. The most effective collection method for determining what species are present throughout the water column is called a vertical haul. If the students have determined the depth to which light can penetrate (the maximum Secchi depth), this is the depth at which the vertical plankton haul should begin.

1. Attach the chain or rope to the plankton net. Make sure the collection jar attached to the plankton net is set up to not allow water to continually pass through it. If there is a tube at the end of the collection jar, it should contain some sort of device to cut off the flow through the tube (see picture at right).
2. With the boat anchored at the deepest spot of the lake, lower the plankton net to the starting depth.
3. One student should begin pulling the chain or rope to the surface with a slow, steady movement.
4. When the net reaches the surface, have the student rinse the sides of the net by dipping the net vertically into the water. It is important that the top of the net stays above the surface of the water so the plankton that were collected stay within the confines of the net.
5. Empty the contents of the collection jar into the sample bottle. Return the sample bottle to the classroom for identification.



**A Plankton Net.**

6. Remove a sample from the sample bottle with the pipette. Place a few drops on a microscope slide.
7. Place the slide under the microscope lens. Refer to the identification book to determine the type of plankton.
8. Have the students trace each organism they see in a notebook. Label each drawing with the species name.



### **Part III: Making Equipment for Lake Studies**

Limnological equipment can be very expensive. Making your own equipment is a cost-effective means of supplying your students with the proper tools to carry out the field studies. And, having the students help make the equipment can be a valuable learning experience!

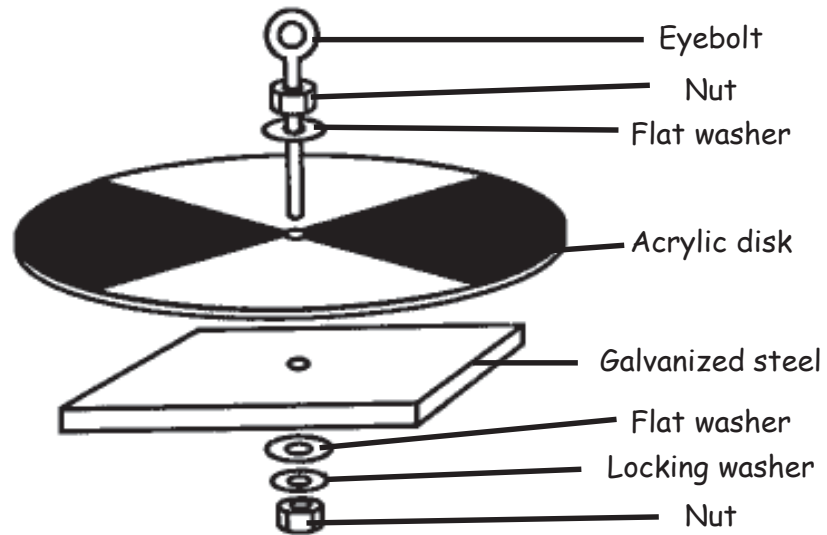
There are several pieces of equipment that can be easily constructed with detailed instructions. The following sections will provide instructions for assembling a Secchi disk, an integrated sampler, a plankton net, and a Viewscope.

## Activity 10: Secchi Disk

The Secchi disk is used frequently by limnologists. While it is a simple piece of equipment, a Secchi disk can offer a limnologist some very important information about a lake or pond. The Secchi disk is used to measure the clarity of the water, or how deep light penetrates the water. This easy measurement, when collected over a period of time, can show a limnologist if water quality is improving or declining.

### Necessary Materials

- ◆ 20-cm diameter acrylic circle (1/2" thickness)
- ◆ 15-cm diameter galvanized steel plate (1/8" thickness)
- ◆ Eye bolt (5/16" by 2")
- ◆ Two flat 5/16" washers
- ◆ One locking 5/16" washer
- ◆ Two 5/16" nuts
- ◆ Hand drill
- ◆ Flat black rust resistant spray paint
- ◆ Flat white rust resistant spray paint
- ◆ Masking tape
- ◆ Nylon rope or calibrated chain (length varies depending on depth of water to be sampled)



Secchi Disk set up for construction.

### Directions

1. Divide the 20-cm acrylic disk into quadrants using masking tape. Spray paint alternating quadrants black and white, so that you have a disk that is similar to that pictured above. Let the paint dry. Apply a second coat of paint, if necessary.
2. Drill a hole of 3/8" through the center of the acrylic disk and the galvanized steel disk.
3. Assemble disks with eyebolt (5/16" in diameter). Use flat washers between the disk and nut, and between the steel plate and locking washer. Use 5/16" nuts at the top of the eyebolt and to bolt the steel plate on the underside of the acrylic disk.
4. Attach a brass chain or rope calibrated by 0.5 meter increments to the Secchi disk to use in the lake.
5. Note: If rope is used, avoid using cotton rope since it stretches when it is wet. You may want to use non-stretching white plastic coated wire-core clothesline. Make sure to bend and straighten the line before you buy it to make sure that it will lie straight. Calibrate the rope at 0.5 meter increments using permanent pen, or by tying knots at each 0.5 meter interval.

## Activity 11: Integrated Sampler

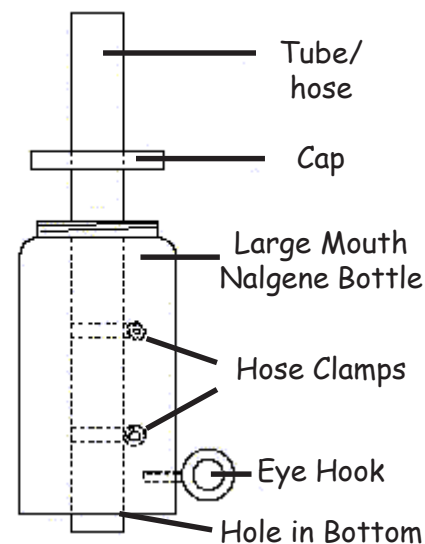
One of the most useful pieces of equipment for limnological studies is an integrated sampler. This tool can be an effective means for collecting water samples that will be analyzed for chlorophyll. The benefit of using an integrated sampler versus a Kemmerer bottle or Van Dorn sampler to collect these water samples is the integrated sampler provides a full water column sample. A Kemmerer bottle may possibly only contain sections of the water column.

### Necessary Materials

- ◆ 1" diameter Tygon tubing or garden hose (length varies depending on depth of water to be sampled)
- ◆ Wide-mouthed plastic bottle with cover
- ◆ Eyebolt (1/8" by 2")
- ◆ One nut (1/8")
- ◆ Two washers (1/8")
- ◆ Material for weight (sand or cement work well)
- ◆ Strong glue (such as epoxy)
- ◆ Small hose clamps (1.5 to 2" diameter)
- ◆ Permanent ink marker (for marking tube)

### Directions

1. Cut the tygon tubing or garden hose (recommended diameter of 1") to the desired length (the length of the tubing should exceed the sampling depth by at least 0.5-meters). Mark the tube at every half-meter using a permanent pen.
2. Using a drill very carefully, cut hole slightly smaller than the tube in the cap and bottom of a 1-Liter large mouth Nalgene bottle.
3. Place cap on tube, followed by the hose clamps positioned about 4 to 6 inches from end of tube. Tighten the tube clips so they will not slip.
4. Place the bottle so approximately one inch of tube protrudes through the bottom of the bottle. Slide the cap up the tube such that the bottle is open.
5. Screw and secure the eyehook into bottle, using a nut and washers. (You may need to drill a small hole in the bottle first.)
6. Apply epoxy to seal tube and bottle.
7. Mix concrete according to instructions and pour in the bottle around the tube until bottle is filled to the bottom of the neck.
8. Slide cap in place and screw on tight. Apply epoxy to seal tube and cover.
9. Allow sampler to dry for 24 hours before use.
10. When using for sample collection, fasten a calibrated chain or rope to the eye hook. (Note: The chain or rope should be calibrated in half-meters.)



**Integrated Tube set up for construction.**

## **Activity 12: Plankton Net**

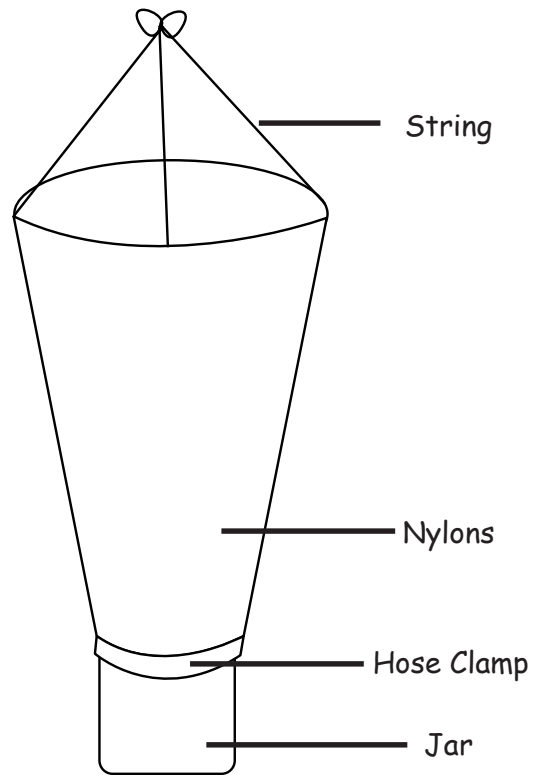
Many students tend to find the collection of plankton is the most enjoyable task for a field trip. This gives them the opportunity to see the microscopic creatures living in the water.

### **Necessary Materials**

- ◆ Nylons
- ◆ Wire coat hanger
- ◆ Small jar, preferably transparent plastic
- ◆ Wire cutter
- ◆ Pliers
- ◆ Sewing needle
- ◆ Strong sewing thread
- ◆ String
- ◆ Hose clamp or twine

### **Directions**

1. Cut off one leg of the nylons.
2. Untwist the hanger and make a circle. Cut off any excess length of the hanger with the wire cutters.
3. Use the pliers to twist the two ends of the wire together to complete the circle.
4. Pull the end of the nylon leg over the wire circle, fold it over, and sew with the needle and thread to secure the nylon to the circle.
5. Cut three holes in the nylon, evenly spaced around the circle.
6. Cut three even pieces of string, and run them each through the holes in the nylons and over the wire.
7. Tie the strings around the wire, and tie the other ends together.
8. Cut a small hole (about 1/4" to 1/2" up the nylon) in the nylon's toe. Pull it over the jar, and secure it to the jar with twine. Tie the twine tightly or use a hose clamp.



**Plankton Net set up for construction.**

## Activity 13: Viewscope

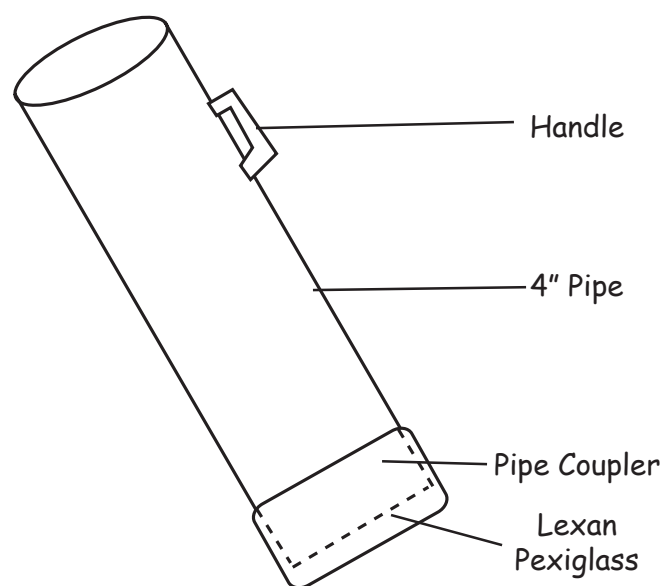
A Viewscope can come in handy when searching for submerged plants during the Aquatic Weed Survey or for Transparency activity.

### Necessary Materials

- ◆ One 3-ft section of 4" diameter plastic pipe (suggest ABS pipe, but PVC may be used)
- ◆ One 5 1/2" pull handle
- ◆ Screws (for handle)
- ◆ One 4" ABS coupler
- ◆ One 4 3/8" diameter lexan disk (this is a non-breakable pexiglass; have this cut at your local glass repair shop if possible)
- ◆ Clear silicone rubber sealant
- ◆ Drill and screw driver
- ◆ Weatherstripping for around the top of the Viewscope

### Directions

1. Make sure the cut of the 4" diameter pipe is square and straight.
2. If the inside of the pipe is not black, either paint the inside a flat black color, or rough the inside with steel wool or sand paper. This ensures that the surface will not glare.
3. Attach the handle about four inches from one end of the pipe. If using ABS pipe, a screwdriver should work to fasten the screws. If PVC pipe is used, the holes will need to be pre-drilled for the screws.
4. At the end of the pipe opposite the handle, run a bead of clear silicone rubber sealant on the end of the pipe. Place the lexan disk on the bead of sealant.
5. Smear a small amount of silicone sealant on the outside of the pipe one-half inch from the end of the pipe with the lexan. Slide the coupling over the end and twist slightly to evenly distribute the sealant. Slide the coupling on as far as it will go to protect the lexan disk from becoming scratched.
6. Place weatherstripping around the open end of the pipe.



Viewscope setup for construction.  
(Not to scale.)



## **APPENDIX**

The following pages include examples of field data sheets. You may choose to use these or have the students create similar forms.

Also, a resource list for equipment and kits to analyze samples is included on the last page.

## Shoreline Development Field Data Sheet

Lake Name: \_\_\_\_\_ Town: \_\_\_\_\_

Date: \_\_\_\_\_ Weather: \_\_\_\_\_

Group Members: \_\_\_\_\_

---

**Shoreline Development (general):** Natural (trees and shrubs, few residential dwellings)  
Semi-natural (well-spaced, sparse residences; scattered clearings)  
Moderate development (more than half shoreline with houses)  
Highly developed (many residential and commercial areas)

**Areas of concern** (note any specific problems here): \_\_\_\_\_

---

**Other comments:** \_\_\_\_\_

---

**Suggestions to improve the shoreline:** \_\_\_\_\_

---

**Were photos taken?** Yes    No

If yes, how many: \_\_\_\_\_ and locations: \_\_\_\_\_

---

Include a sketch of the shoreline showing major land uses (or attach a lake outline map).

## Stream Survey Field Data Sheet

Lake Name: \_\_\_\_\_

Stream Name: \_\_\_\_\_

Station Name: \_\_\_\_\_

Town: \_\_\_\_\_

Date: \_\_\_\_\_

Weather: \_\_\_\_\_

# Photos taken: \_\_\_\_\_

Samples collected?      Yes      No

Locations of samples: \_\_\_\_\_

### **General characteristics**

Pipes or culverts present?      Yes      No

If yes, how many? \_\_\_\_\_ Locations: \_\_\_\_\_

### **Road conditions**

Number of dirt roads: \_\_\_\_\_ Number of paved roads: \_\_\_\_\_

Any erosion or other poor conditions? \_\_\_\_\_

### **Streambank conditions**

Exposed soils?      Yes      No

Erosion?      Yes      No

Location of erosion: \_\_\_\_\_

Percent shrub/tree cover on streambank: \_\_\_\_\_

### **Residential or commercial areas**

Runoff from roofs or parking lots:      Yes      No

Comments: \_\_\_\_\_

Erosion or exposed soils:      Yes      No

Comments: \_\_\_\_\_

Include site drawing on back

## Benthic Macroinvertebrate Survey Field Data Sheet

Stream Name: \_\_\_\_\_

Town: \_\_\_\_\_

Station Name: \_\_\_\_\_

Date: \_\_\_\_\_

Weather: \_\_\_\_\_

Group Members: \_\_\_\_\_

Erosion Present?      Yes      No

If yes, describe: \_\_\_\_\_

### Stream Characteristics

Bottom Composition: (choose one)

Sandy

Pebbles

Large rocks

Leaves and other debris

Water Quality: (choose all that apply)

Clear

Turbid

Odor

Other: \_\_\_\_\_

## Equipment and Test Kit Suppliers

Ben Meadows Company  
P.O. Box 5277  
Janesville, WI 53547-5277  
(800) 241-6401  
[www.benmeadows.com](http://www.benmeadows.com)

Carolina Science and Math  
(800) 334-5551  
[www.carolina.com/](http://www.carolina.com/)

Cynmar Corporation  
P.O. Box 530  
Carlinville, IL 62626  
(800) 223-3517  
[www.cynmar.com/](http://www.cynmar.com/)

Fisher Science Education  
(800) 955-1177  
<http://fisheredu.com/>

Forestry Suppliers, Inc.  
P.O. Box 8397  
Jackson, MS 39284-8397  
(800) 360-7788 (catalog request)  
[www.forestry-suppliers.com](http://www.forestry-suppliers.com)

Hach Company  
P.O. Box 389  
Loveland, CO 80539  
(800) 227-4224  
[www.hach.com](http://www.hach.com)

Sargent-Welch (VWR International)  
P.O. Box 5229  
Buffalo Grove, IL 60089-5229  
[www.sargentwelch.com/](http://www.sargentwelch.com/)

Science Kit and Boreal Laboratories  
777 E. Park Dr., P.O. Box 5003  
Tonawanda, NY 14150  
(800) 828-7777  
[www.sciencekit.com/](http://www.sciencekit.com/)

Ward's Natural Science Establishment  
(800) 962-2660  
<http://wardsci.com/>

Water Monitoring Equipment & Supply  
P.O. Box 344  
Seal Harbor, ME 04675  
(207) 276-5746  
[www.watermonitoringequip.com](http://www.watermonitoringequip.com)

Wildco (Wildlife Supply Company)  
95 Botsford Place  
Buffalo, NY 14216  
(800) 799-8301  
[www.wildco.com](http://www.wildco.com)

